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STATUS OF THE POLISH AUTOMOTIVE INDUSTRY IN 1947

[Comment: The following information, taken from 1947 Polish periodicals, gives an outline of the early postwar development of Polish production of automotive vehicles and accessories. It is believed that the technical specifications still apply, with minor adjustments, to standard models in series production today.]

THE DEVELOPMENT OF THE AUTOMOTIVE INDUSTRY IN POLAND -- Warsaw, Przeglad Samochodowy, Vol I, No 6, Jun 47

There was no Polish automotive industry at all at the end of World War I in 1918. All the motor vehicles then in operation in Poland had come from abroad. Moreover, no major repairs were made in the country.

In 1918, Poland had a rather substantial number of automotive vehicles, a hodgepodge of varied makes, predominantly war surplus, left by the armies which had been engaged in the war.

Shortly after the war's end, the CWS (Centralne Warsztaty Samochodowe, Central Automotive Workshops) were built in Warsaw. The CWS devoted the first few years of its existence solely to repair and maintenance of existing motor vehicles.

In 1925 - 1927, a group of engineers proceeded to design the first Polish passenger car, or, rather, several variations of that car. The CWS was by then sufficiently equipped with machine tools to tackle the construction of the experimental models of those cars.

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After certain changes and improvements on one of these models, a small series of 30-90 cars was produced. These cars were incontestably of good quality and, for their time, quite modern. Three cars from that series, after continuous operation, remained in good condition in the CWS, subsequently renamed the PZInz (Panstwowe Zaklady Inzynierii, State Engineering Works) until the outbreak of the war in 1939. Notwithstanding these real achievements, automotive production came to a standstill through lack of foresight in government circles and the beginning of the economic crisis, which stopped the flow of investment capital.

Ursus, a Warsaw concern producing industrial engines, alone displayed great initiative by securing a considerable financial loan from the government. This was used to buy patent rights from Spa, the Italian firm, and to erect a special plant in the Wlochy suburb of Warsaw for the serial production of 1.5-ton trucks. The first several hundred of these trucks were very well received when Ursus suddenly ceased further production.

In 1930, automotive requirements were covered solely by imports from abroad. These were small because it was a period of increasing economic crisis, combined with an ineffectual policy of public taxation.

Attempts to produce automobiles were made in that period, but none had any worthwhile results. One of these attempts was undertaken by Stefan Tyszkiewicz, an engineer who had obtained prototypes made in France, road-tested, and fully satisfactory in performance, and tried to interest Polish industry in them. It was even decided to build a plant, but certain mishaps, such as a fire in the assembly-line room, caused discouragement, so that further construction was abandoned.

Another attempt was undertaken by As(Ace), a Warsaw firm which had even activated an assembly plant. Many individual parts and subassemblies were imported from abroad, although a certain number of them was made in the country. Scores of cars were built, and then the enterprise was liquidated.

Enthusiasm and effort were not lacking, the designers (CWS) were able, and Ursus had promising beginnings of serial production, but the automobile industry did not develop at all. The real reason for its failure to develop was the total lack of auxiliary industries.

Every automotive plant, except for the US giants, manufactures only a small number of components. The rest are supplied by subcontractors.

In 1939 the PZInz in Warsaw produced only 26 percent of the chassis components in its excellently equipped and completely modern plant. The remainder, 74 percent, came from other plants, as follows: tires from Stomil; wheel rims and springs from Ostrowiec; frames from Starachowice; fenders, radiators, fuel tanks, and mufflers from Bielany; storage batteries from Piascw; generators, ignitions from Magnet-Popawski; induction coils and signals from Swel; headlights, stop lights, and other lights from Marciniak; speedometers and other gauges from Romer-Lwow; shock absorbers and hydraulic brakes from Klinger-Lodz: carburetors from Solex; electrical wiring, rubber products, steering wheels, Hardy knuckles, and pipe forgings from Wspolnota Interesow, etc. Other items from subcontractors included ball bearings, gaskets, and minor parts of sheet-metal, fiber, and cork.

As already mentioned, there were no auxiliary industries in the beginning. The CWS, Ursus, Stetysz, and As firms all had to import a great quantity of individual parts and subassemblies from abroad and pay import duties and transportation costs. They were dependent on the terms, honesty, and precision of their foreign sources. A few parts were manufactured in Poland in small quantities, hence, at high cost.

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In 1931, the signing of a licensing agreement between PZInz and Fiat, an Italian automobile factory, opened a new chapter in the history of the Polish automotive industry. Fiat was to provide the blueprints, instruments, gauges, layout, and some machine tools. These obligations were fulfilled entirely. It was possible to start the immediate assembly of automobiles from Italian parts and thus to acquaint the buyers with these makes and, later, to begin the erection of a plant. At the same time, orders were placed with domestic subcontractors for different parts and subassemblies. Many of these firms lacked adequate tools for profitable operation, hence, they had to be paid in advance or guaranteed future orders or permanent contracts.

Many orders could not be placed at all because they necessitated a new kind of production unknown in Poland so that new plants had to be built from scratch and given technical and financial support. This difficult project could be carried out without haste because, if a particular domestic product was not supplied on time, it could be replaced immediately by an Italian product. The process of eliminating Italian parts was slow, but it was finally completed by 1935, and the Fiat name plates on the radiators of automobiles were changed to read Polski Fiat (Polish Fiat). Thus, by means of the agreement with Fiat, not only were the auxiliary automotive industries developed, but a large number of skilled workers was trained.

This undertaking, though successful in principle, had one serious drawback: it paralyzed attempts to create an automotive vehicle of Polish design. A design does not merely satisfy nationalistic pride. An independent design makes it possible to use native resources, norms, measurements, and screw-threads, while a foreign license limits these possibilities. A firm which takes advantage of a license must use materials specified by foreign norms. It must apply standards of measurement and screw-threads that are often quite different from domestic ones. Such a firm must carry out changes dictated by the licensing firm. It was thus a matter of course that when the production of the Polski Fiat was mastered, and when the auxiliary industries were able to produce in quantity and to improve the quality, several Polish models were worked out. These included Sokol 1000 and Sokol 600 motorcycles, a small TK patrol tank (though still with a Fiat engine), and others.

In spring 1937, after the completion of the model of a large passenger car, it was decided to design and construct a 4.5-ton truck. The first engine was ready by December 1937, and the first models of the chassis were completed in spring 1938. At the end of 1938, it was resolved to begin the series production of the 4.5-ton truck, to discontinue the production of Fiats by 1940, and to enlarge the PZInz plant. This decision was followed by hurried preparations and purchases of new machine tools. In July 1939, the first series of 100 trucks left the plant.

Estimates based on data gained during the production of trial series showed that with an annual production of 6,000 units, the unit cost, excluding profit, would be 12,500 zlotys, which was equivalent then to the price of the chassis of a 3-ton Chevrolet truck. It was found that a satisfactory profit would be obtained at an annual production rate of 10,000 units. The successful trials of PZInz and the good prospects of profit encouraged other private concerns to undertake the production of automotive vehicles. Lilpop, a Warsaw corporation, holding a license from the General Motors Company, began, in 1938, to assemble Chevrolet cars, simultaneously building a plant in Lublin to switch gradually to independent production. There also appeared assembly plants of Renault cars at the locomotive works in Chrzanow and of several German models in the Wspolnota Interesow in Slask. The Bielany factory in Warsaw had also independently designed and constructed a car with an engine having a 1.3-liter stroke volume. The experimental model built in spring 1939 was very successful. Work preparatory to full-scale production was very advanced, and there was every prospect that it would begin in a short time.

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The war blotted out the entire picture. PZInz was literally leveled. The plants of auxiliary industries, many seriously damaged, were converted to other production. In the beginning of 1940, a group of former PZInz employees who had escaped the holocaust, decided to reproduce at least the blueprints. The work progressed quickly, but it had to be modified several times because of important though scant reports of new materials, new methods of tooling, and other locally unknown solutions to engineering problems which managed to penetrate into Poland. There plans, continuously elaborated and modernized, were painstakingly concealed in several places. Nevertheless, all this caution did not prevent their total loss during the Warsaw Uprising of 1944.

After a period of chaos after the end of the war, a decision was taken in May 1946 to undertake the production of a 3.5-ton truck. Today, the blueprints of the whole chassis are finished. Further work is in process at the following three places:

1. The experimental section at Ursus, near Warsaw, is working on several models and will probably finish the job by the end of 1947. Tests will be made, followed by minor adjustments, before final approval of the model.

2. The production section of the ZPMot (Zjednoczenie Przemyslu Motoryzacyjnego, Association of the Automotive Industry) in Warsaw, quite independently of the experimental section, is now working out series production.

3. The automotive plant in Starachowice, on the basis of the blueprints in its possession, is now planning the factory layout and is purchasing and accumulating suitable machine tools. It maintains constant liaison with both the experimental and the production sections.

The major task of beginning automotive production in Poland still lies ahead, and Poland faces great difficulties in mastering the technology and in raising the auxiliary industries to the proper level.

The motor vehicle now being developed, described in the February 1949 issue of the Przeglad Samochodowy, is not a copy of any existing make. It was difficult to select an existing model that would satisfy Polish requirements. If the most suitable of existing models had been selected, it would still have to be redesigned according to Polish production and maintenance capabilities and according to Polish road characteristics.

The preparation of blueprints from an existing model, followed by alterations, would involve more time than the execution of original blueprints. -- Professor Dr Wevner, Chief, Automotive Vehicle Production, Central Administration of the Automotive Industry.

AUTOMOTIVE ENGINE DESIGNED BY B. WIECZOREK AND PRODUCED BY PZS-1 AT GLIWICE -- Warsaw, Przeglad Samochodowy, Vol I, No 4, Apr 47

By B. Wieczorek, Mech Engr

B. Wieczorek started work on the design of the CW6W automotive engine in May 1945, as part of the project for the design of a 3-ton truck. The model was produced at the PZS-1 (Panstwowe Zaklady Samochodowe, No 1, State Automotive Plant No 1) in Gliwice.

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The specifications of the model and those of an alternative design are as follows:

Data	SC6W	SC6W-bis
Type	Vertical, in-line	Overhead value
Method of operation	Four-stroke (Otto)	Same
Stroke	95 mm	95 mm
Bore	85 mm	95 mm
Displacement	3,234 cc	3,618 cc
Compression ratio	6.4 : 1	7.3 : 1
Maximum power	75 hp at 3,000 rpm	90 hp at 3,000 rpm
Fuel consumption	270 g per hp-hr	285 g per hp-hr
Camshaft timing	Intake opens 3°, 5° before top dead center Intake closes 52°, 50° after bottom dead center Exhaust opens 42°, 48° before bottom dead center Exhaust closes 2°, 5° after top dead center	
Carburetor	Ford	Domestic
Power per 1,000 cubic centimeter	23.4 hp	25.0 hp

The SC6W engine was operated for 320 hours under full load conditions, which is the equivalent of about 27,000 kilometers of driving. Inspection after this period showed that all parts of the engine were in good condition. The development of the SC6W engine is now in its final stage.

The engine block has no permanent points for mounting, only surfaces to which clamps of any kind can be fastened. This detail in design makes it possible for the engine to be used interchangeably in almost all types of trucks between 2.5 and 4 tons. (Additional measurements indicated the possibility of using this engine in the following types of vehicles: Opel Blitz, ZIS-5, Studebaker, Chevrolet, GMC, Bedford, and Dodge). The engine block has deep fins and replaceable ("wet") cylinder liners. Thus, the block can easily be cast from common machine-cast iron (Ge 12.91 -- cast iron with no special specifications).

The only requirement is a clean surface and the use of proper admixtures to facilitate machining.

The liners are made of a special centrifugally cast iron, with 0.8-percent manganese content and a maximum of 3.5 percent carbon, 2.5 percent silicon, 0.1 percent sulfur, and 0.8 percent phosphorus. The piston rings are made of cast iron of similar composition. The rings are heat-treated under tension. Both rings and liners showed a minimum of wear.

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The pistons are made of a light alloy consisting of 11 percent silicon, 5.7 percent copper, 0.48 percent zinc, and the remainder, aluminum. The alloy used in the model, consisting of 6.4 percent copper, 5.2 percent nickel, and 0.9 percent zinc, gave unsatisfactory results, primarily because it was impossible to heat-treat it properly.

The connecting rod, which is drop-forged is not heat-treated beyond the normal processing. The lower end is cast directly in a bearing alloy with a low tin content, and the upper end is lined with a bronze sheet (Fod).

The crankshaft is made of carbon steel and has four bearings. The second bearing (counting from the flywheel) stabilizes the shaft axially. Bored openings carry the lubricant from the main bearings to the connecting-rod pins. The fan-belt pulley, situated at the front, is connected with a metal and rubber damper. (At present, a method of damping vibrations at the point of origin at the individual connecting rods, is being designed. The results attained up to now allow for high expectations that dampers can be built as cheaply as attached counterweights. If this attempt is successful the cost of crankshaft production and control will be lowered considerably. The crankshaft drives the camshaft by a pair of bevel gears, the larger of which is made of bakelite-impregnated cloth. The camshaft of the model is equipped with set-in cams. These make it possible to determine experimentally the best camshaft timing. The disc tappets work against hollow valve stems. The valve rockers are placed in groups of four on common pins. The liners are made of bronze sheet. Pressure lubrication is used, handled by a reduction valve through the hollowed pins of the valve rockers and distributed at the points of contact with the stem and with the valve. The valves, made of chrome-silicon steel, operate in cast iron guides and are the only parts of the engine made of alloy steel. To save alloy steel, the valve has been butt-welded of two parts (the head, made of chrome-silicon steel, and the rod, made of carbon steel). The base of the valve spring is fastened by two steel cases. The crankcase and the distributor housing are made of welded sheet-iron stampings. Temporarily, these housings will be cast from aluminum because of the difficulties in obtaining suitable presses.

The cylinder head is made of cast iron, and the valves operate in guides made of special cast iron. The combustion chamber is cylindrical and is machined. Its shape allows a compression ratio of 6.5:1. An alternative combustion chamber applied in the SC6W-bis engine permits an increase in the compression ratio to 7.5 : 1. Its shape is shown in figure 9. It was designed to achieve a thorough mixing of the gases at the final moment of the compression stroke. Simultaneously, its shape, by creating a kind of additional chamber under the valves, in addition to using the inertia of the gases resulting from retanded closing of the exhaust valve, gives a better evacuation of the combustion chamber at the end of the exhaust stroke. This permits better and more thorough combustion.

The circulation of the lubricant was worked out very carefully because of the low quality of lubricants. The pressure circulation system has a replaceable external filter through which the lubricant is fed from a gear pump to all the bearings of the crankshaft and of the valve rockers. The lubrication pressure equals 4 atmospheres between 800 and 3,000 revolutions per minute. The pressure is made constant by means of the reduction valve which is situated in the body of the gear pump. The circulation in the crankcase is augmented by a nozzle on the lower end of the crankshaft. This sprays the lubricant on the friction surface of the cylinder and on the cam lobes. Openings ventilate the crankcase chamber and the valve chamber.

The cast-iron flywheel has a fitted, toothed rim to connect with the starter. A dry, single-plate clutch is located on the flywheel.

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The cooling water is circulated by a centrifugal pump which is connected to the fan. The V-belt of the fan drives the air-brake compressor and the generator which, by being movable, provides tension on the belt.

The radiator consists of 29 replaceable elements in the form of drawn, ribbed steel tubes which are held in the water chamber by water-tight rubber washers. This design simplifies radiator repairs, reducing them to the exchange of an inexpensive part with the help of an ordinary wrench.

The table on the following page gives comparative data on the design produced.

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Comparative Table of 3 - 3.5 Liter Engines

Make	Displacement (1)	Bore/Stroke Ratio	Compression Ratio	Hp	RPM	Hp/L	No of Cylinders	Kg per Sq CM	Type
Opel Blitz 31	3,626	90/95	6.00	75 at	3,200	20.8	6	5.8	Truck
Borgward	3,548	78/125	--	63 "	3,000	18.0	6	5.2	"
Krupp 22H143	3,308	102/160	--	50 "	2,500	15.1	4	7.5	"
Ford BB	3,285	98.4/108	4.60	45 "	2,000	14.0	4	6.2	"
BMW 335	3,500	92/110	5.80	90 "	3,000	25.7	6	7.7	Passenger car
Ford V8 - 51	3,585	77.5/95	6.30	82 "	3,000	33.8	8	6.9	Truck
PZS-1 - SC6W	3,234	85/95	6.42	75 "	3,000	23.4	6	7.0	"
PZS-2 - SC6Wbis	3,618	90/95	7.12	90 "	3,200	25.0	6	7.0	"

-- B. Wieczorek, mechanical engineer

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A TRUCK OF POLISH MAKE -- Warsaw, Przeglad Samochodowy, Vol 1, No 2, Feb 47

During the first half of 1946, preliminary work was begun on a type of truck that would be best suited to Polish requirements. It was decided that this should be a 3.5-ton truck with an 85-horsepower engine developing 2,800 revolutions per minute. The designing and detail work tasks of this vehicle were given to the Centraine Biurc Badani Konstrukej (Central Research and Designing Bureau in Lodz). Today all of the principal parts of this model truck are being worked out at the Ursus experimental division. The engineering department is making the blueprints of the remaining assemblies.

The entire truck has been designed as simply as possible; the lowest possible production costs and easy servicing have been kept in mind.

The frame was designed so that the right and left longitudinal members could be pressed out of the same mold. All four springs are ordinary leaf springs held on one side by a bolt and on the other, by a cast-iron spring cushion. A four-wheel hydraulic system is supplemented by an auxiliary vacuum brake. Hydraulic shock absorbers are placed only in the front end. The parking brake operates only on the rear wheels. The tires are 7.50 x 20 or 8.25 x 20 in size (the wheels in the rear are the same as the front wheels). The differential has a single spiral-bevel gear and a gear ratio of 8:49, which guarantees a speed of 75 kilometers per hour at nominal engine revolution. The transmission has four speeds; the third and fourth are silent.

The driver's seat is at the side of the engine, allowing room for a large loading surface despite a very small wheel base. The engine was placed as far to the rear as possible to permit the use of undivided transmission shaft, requiring no support.

The engine has six low-compression cylinders and overhead valves. A longer piston assembly could raise the compression ratio to 1:10 if the engine is converted to generator-gas propulsion. [sic]

To increase facility in production and ease in repairs, so-called wet cylinder liners are forced into a standard cylinder block, constituting cylinders in themselves, directly washed by water. The crankshaft has four main bearings. Lubrication is under pressure, and the oil is thoroughly filtered by means of slotted filter.

The engine is water cooled, and a built-in thermostat insures a very rapid temperature rise to the normal level soon after starting.

The single-plate dry clutch automatically increases pressure with an increase in engine revolution and decreases the pressure on the clutch pedal while running idle.

The following are data on the chassis and the engine:

Undercarriage

Wheel base	3,000 mm
Front-wheel track	1,600 mm
Rear-wheel track	1,600 mm
Tire dimensions	7.50 x 20 or 8.25 x 20
Rim dimensions	7.00 x 20
Height of upper frame, loaded	750 mm

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Undercarriage

Vehicle height without bows	2,100 mm
Vehicle length (bumper to end of chassis)	5,500 mm
Vehicle width	2,100 mm
Bed dimensions	3.750 x 2,000 x 600
Loading surface	7.5 sq m
Minimum turning radius	6.5 m
Weight	
Chassis	2,600 kg
Body	750
Vehicle, empty, completely equipped (oil, fuel, water, spare, tools)	3,500 kg
Load capacity	3,500 kg
Carrying capacity of chassis (load, body, equipment)	4,640 kg
Maximum vehicle weight, loaded	7,240 kg
Front-axle load	2,360 kg
Rear-axle load	4,880 kg
Maximum load per horsepower	85 kg
Rear-axle ratio	8:49
Ratio of first gear	1:6.4
Ratio of second gear	1:3.8
Ratio of third gear	1:1.8

Engine

Bore diameter	92 mm
Stroke	105 mm
Number of cylinders	6
Piston displacement	4,180 cc
Power at 2,800 revolutions per minute	85 hp
Maximum torque at about 1,700 revolutions per minute	28 kgm
Firing order	1, 5, 3, 6, 2, 4
Compression ratio	6.2:1

-- Professor Dr Werner, Chief, Automotive Vehicle Production, Central Administration of the Automotive Industry

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THE SOKOL 125 AND SHL 125 MOTORCYCLES -- Warsaw, Przeglad Samochodowy, Vol I, No 5, May 47

In October 1946, the Zjednoczenie Przemyslu Motoryzacyjnego Association of the Automotive Industry decided to manufacture Sokol 125 and SHL 125 model motorcycles.

The engineering department of the Association of the Automotive Industry started work on the blueprints. The new products division, after coordinating its subordinate factories, started preparatory work on model construction.

At present, six models are undergoing tests with satisfactory results. The tests are expected to be completed in the third quarter 1947. At approximately that time, 200 SHL 125 motorcycles of the first experimental series will be ready.

The Association of the Automotive Industry has also initiated a detailed study of serial production, with a target for manufacturing up to 1,000 motorcycles per month.

There will be many difficulties in starting the production of Polish motorcycles for the first time. Nevertheless, serial production of motorcycles and organized servicing will be ready for the domestic market during 1948.

For general orientation, some technical descriptions and drawings are provided below, applicable only to the above-mentioned models. After the completion of tests, a subsequent article will include test results and additional technical details.

Engine

The engines in the Sokol 125 and the SHL 125 motorcycles are identical. The engine is a single cylinder, two-cycle, air cooled engine with a displacement of 123 cubic centimeters, and is rated 4.7 horsepower at 4,800 RPM. The cylinder bore is 52 millimeters and the piston stroke 58 millimeters. The capacity of the compression chamber is 25 cubic centimeters, resulting in a compression ratio of 6 : 1. Fuel consumption averages 2.25 liters per 100 kilometers.

The cylinder is made of cast iron; the head, pistons, and crankcase are made of aluminum alloy.

The foot-operated, three-gear transmission is located, together with the engine, in the center of the body frame.

Engine Cross Section

The foot starter and the foot gearshift lever are placed on the left side of the engine.

The drive is arranged as follows: engine - transmission - rear wheel - chain drive. The engine has a wet cork clutch.

The carburetor to be used in this series is the Polish carburetor already in production, the ZP Mot G-16, with air filter.

Ignition is effected through a generator called "magneto," produced by Marciniak, a Polish firm.

Polish IES spark plugs are used in the engine. They have a thermal value of 175 and a thread of M14 x 1.25.

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Chassis of the Sokol 125

The chassis of the Sokol 125 features a welded tube frame. The front fork is made of pressed sheet steel, with a rubber shock absorber. The spoke wheels mount Stomil 3.00-19 tires.

The fuel tank holds 8.5 liters of gasoline and oil mixed in a proportion of 20 : 1.

The saddle is mounted on two compression springs. The motorcycle is equipped with two independent brakes: a front-wheel hand brake and a rear wheel foot brake.

Chassis of the SHL 125

The main difference between the chassis of the Sokol 125 and that of the SHL 125 is the frame. The SHL 125 is made of pressed sheet steel forming a wide "V" frame.

The second difference between the two chassis is that the front fork of the SHL 125 has a spring shock absorber.

The driver's seat is suspended by two tension springs.

There are also differences in the fuel tank. The SHL 125 has larger fuel tank capacity, about 10 liters. Other differences are in the dimensions of the wheel base, over-all height, etc. The chassis of the SHL 125 is approximately 10 kilograms heavier than the chassis of the Sokol 125, which weighs about 75 kilograms.

The designers believe that the maximum speed of each motorcycle in high gear will be approximately 70 kilometers per hour. -- Engineer Pachu'ski, Chief, Motorcycle Production Section, Central Administration of the Automotive Industry.

THE USE AND MAINTENANCE OF THE 3-STE-80 STARTER STORAGE BATTERY -- Warsaw, Przeglad Samochodowy, Vol 1, No 4, Apr 47

Characteristics of the 3-STE-80 Battery

The standard voltage of the 3-STE-80 battery is 6 volts. The capacity after 20 hours of charging equals 80 ampere-hours.

After 10 hours of charging, the intensity of the discharge current is 7 amperes (with 1.7 volts in each cell). The capacity after 10 hours of charging amounts to 70 ampere-hours.

The intensity of the discharge current after 5 minutes of charging is 220 amperes (with 1.5 volts in each cell). The capacity after 5 minutes of charging is 18.3 ampere-hours.

The foregoing capacities are applicable to new batteries after four rounds of charging and discharging, with a density of the electrolyte of 1.285 ± 0.005, at an average temperature of 30 degrees centigrade during discharging.

Battery Conservation

New, dry, uncharged batteries should be stored in a dry place, if possible, heated during the winter. The battery caps should be fastened tightly. The rubber washers should not be removed. The terminals should be covered with industrial vaseline. The batteries should be placed on the shelf with caps upright.

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Preparation of Batteries for Use

To prepare the batteries for use, the cells should be filled with an electrolyte (a solution of sulfuric acid) with a specific gravity of 1.120 at a temperature of 15 degrees centigrade. The batteries must then be charged two or three times.

1. First round of charging and discharging

The charging of the battery should start 4 hours after the electrolyte has been poured in. The level of the electrolyte in the cells should reach 12-15 millimeters above the upper edge of the plates.

The batteries are charged with current of variable intensity (5 and 2.5 amperes). Current of 5 amperes should be used for charging until 2.4 volts has been reached on the terminals of the majority of the cells of the battery. After this, the intensity of the current should be reduced to 2.5 amperes until the completion of the charging process.

The change in voltage takes place while the battery is connected in the charging current.

The approximate time for the charging process is between 50 and 75 hours.

While the battery is being charged, the temperature of the electrolyte in the cells should not exceed 45 degrees centigrade.

The end of the first charging process, with a current of 2.5 amperes, is marked by a considerable discharge of gases from all cells; in addition, the density of the electrolyte and the voltage in all cells become constant in a period of 2 hours.

After the completion of the first charging, the batteries should be discharged uninterruptedly for 10 hours.

2. Second round of charging and discharging

The second and all subsequent chargings are carried out with currents of variable intensities. The intensity of the initial current for charging is between 10 and 15 amperes, and of the second current, 5 amperes. The approximate total capacity in ampere-hours is between 125 and 150.

At the end of the second and all subsequent rounds of charging, the density of the electrolyte should be brought up to normal, i.e., 1.285, ±0.005, at 15 degrees centigrade.

After completion of the second round of charging and after raising the electrolyte's density to normal (1.285, ±0.005, at 15 degrees centigrade), the battery should be discharged uninterruptedly for 10 hours.

If during the second discharging, the battery loses no less than 90 percent of its normal capacity over the 10-hour period, then, after recharging, it can be used. Otherwise, it is necessary to discharge the battery a third time and again check its capacity.

3. Use of the battery

Every 10-15 days, the discharging of the battery should be checked for density of the electrolyte and for voltage under a load. If the cells are discharged 50 percent or more, they must be recharged.

During the winter, the following instructions apply:

a. Warm and heat the batteries. Warm up the engine by running it idle and adjust the speed to enable the generator to discharge the battery.

b. A battery with a cracked case should be repaired.

The density of the electrolyte should correspond to climatic conditions and to the season of the year.

TIRES OF POLISH MANUFACTURE: THEIR PRODUCTION AND CONSERVATION -- Warsaw, Przeglad Samochodowy, Vol I, No 6, Jun 47

Since there is a total lack of foreign literature dealing with the manufacture of tires abroad, all research and tire production at Stomil has been based on prewar experience and fragmentary data left by the Germans.

The prewar quality of Polish tire production has not yet been achieved because theoretical material and technical manpower in the field of tire production were badly depleted during the war. Another reason for the inferior quality of postwar tires is the destruction of Polish industry by the Germans, which has brought about shortages of chemicals, particularly of accelerators such as sulfur, zinc oxide, chalk, gas carbon black, and many others.

The difficulties are increased by the increased postwar demand for commodities. For example, the basic postwar raw material is synthetic rather than natural rubber. This forces the chemical industry to investigate new combinations of readily available raw materials in an effort to approximate prewar quality. Another serious shortcoming is also the low-grade of cotton cord used in the carcass of the tire; this is caused by the manufacturing and raw-material supply difficulties of the textile industry.

The warp of the tire consists of several layers of cotton or rayon cord, permeated with rubber. The layers of cord are separated by thin layers of rubber previously applied to the cord in a calendering machine.

In the part of the tire which rests on the wheel rim, the bead, a steel wire ring of proper circumference' is placed. This ring is rubber-coated and, because it does not expand, it counteracts the expansion of the diameter of the bead under the influence of air pressure and keeps the tire from falling off the wheel rim. Between the carcass and the tread is a layer of buffer rubber called the breaker, which cushions the impact of blows transmitted from the tread and prevents separation of the tread from the carcass. The tread is made of rubber highly resistant to rupture and friction and is grooved to prevent skidding. The sides of the tire or carcass are also protected by a layer of tread rubber.

Modern tires owe their high mileage under difficult conditions particularly to the use of cord, instead of woven fabric, and to improved rubber mixtures.

Formerly, square weaves were used in the manufacture of tires. The air pressure caused friction at all intersections of the warp and woof. The heat generated by pressure and friction acted on the rubber and contributed to its destruction.

Later, cord was used in which the warp of heavy threads is interwoven with a woof of very fine threads having a very low tensile strength. This, cord has high tensile strength only in the direction of the warp, so that several thicknesses or plies must be used crossgrained.

The other important material used in the manufacture of tires is natural rubber, an imported commodity, supplemented by synthetic rubber.

Crude rubber cannot be used directly in the manufacture of tires because it dissolves in gasoline and other hydrocarbons, it has variable elasticity with variable temperature, and its has low tensile strength.

Crude rubber is subjected to strong rolling between rolls with different surface speeds. Under the expansion and compression produced by the rollers and under the resulting heat, the rubber changes into a pliable mass to which various chemicals are added, depending on the purpose of the tire. The mixture is subjected to heat of about 130 degrees centigrade, whereupon the binding of the rubber particles with the sulfur particles occurs, and a number of intricate chemical and physical processes take place.

With this process, called vulcanization, rubber becomes insoluble in gasoline and other hydrocarbons and it has uniform elasticity at all temperatures. The rupture strength of ordinary rubber is about 30 kilograms per square centimeter, whereas the rupture strength of vulcanized rubber in the maufacture of the tread which contains zinc oxide and carbon black is about 340 kilograms per square centimeter.

Research has shown increased tensile strength can be achieved by adding to rubber not only sulfur and other chemical products, but any matter with the following properties: very small dimensions, round surface, and maximum adhesion to rubber. Gas carbon black has all these properties.

In the manufacture of the carcass, consecutive strips of rubberized cord are wound crossgrained on a drum. The length of the cord strips equals the circumference of the tire, and the width of the strips corresponds to the circumferential cross section of the tire, with some material added for the fold around the bead wire. To eliminate air pockets, the layers are rolled with special equipment. The proper size bead is then introduced. The steel wire ring is covered with rubber, and a band of rubberized cord is wound around it, with rubber inset between the band and the bead. The first strips of cord are folded over the steel wire ring, and then, the other layers.

After the cord has been wound in reverse around the bead ring, the first and second protecting strip of rubber-impregnated square-weave fabric is placed on the tire.

After this has been completed, a prepared rubber breaker of the proper thickness is applied. Following that, the rubber tread is added, also of the proper gauge, in a width sufficient to cover the sides of the tire as far as the bead. To prevent airpockets between the layers of cord, breaker, and tread, the rubber should be punctured with a sharp instrument and rolled well so that the tread will adhere perfectly to the other layers. After this, the tire is removed from the drum and is finished by folding the final layers of cord around the bead and around the protective bands.

The tire now has the shape of a cylinder. The final shape of the tire is achieved by expansion, a mechanical process. Into the finished tire a thick-walled tube is placed. This is called a vulcanizing hose, inflated with compressed air. This stretches the threads of the cord. With the tube remaining inside, the tire is placed in a vulcanizing mold and is closed tight on all sides.

The vulcanization of tires takes place in presses or vulcanizing boilers. Water under a pressure of about 20 atmospheres and at a temperature of about 150 degrees centigrade is introduced into the vulcanizing hose by a special opening. Double walled molds are heated by steam at the same temperature.

The water pressure introduced into the vulcanizing hose brings about the expansion of the tire to the dimensions of the form, and the treads of the various layers of cord are subjected to tension and shift among the layers of unvulcanized rubber until the tension is equalized.

The external dimensions of the unvulcanized tire are such that at the moment when the tire is expanded by the vulcanizing hose and fills the form, the stress on all layers of the cord is the same, which makes for the proper operation of all the cords in the later work of the tire.

The plastic mass of the tread, under the influence of the internal pressure in the vulcanizing hose, fills the tread mold, including the inscription, the figures, and other details of the tread-mark. The tire undergoes vulcanization during heating, which takes 35 - 220 minutes, sometimes longer, according to the thickness of the walls of the tire.

After the vulcanization is completed, the form opened, and the tire taken out, the vulcanizing hose is taken out and is used again in the production of the next tire. Such a hose can be used several times. The tire then undergoes technical inspection, after which it is distributed for sale.

The first and basic principle in the maintenance of a tire is careful observance of pressure, in accordance with factory directions. One should also see that the tire carries the prescribed load. The actual load consists of the sum of the weights of the car and passengers or load. One third of the load is carried by the front axle and two thirds by the rear axle.

Minor external damages which cause the cotton fibers of the cord to absorb moisture, greases, oils, gasoline, etc., resulting in decomposition of the tires should be repaired by vulcanization.

It is also important to use a rim as prescribed, according to the measurements of the tire. It is extremely important that the diameter of the rim correspond to the diameter of the tire at the base of the rim or, at least, not differ more than one tire size.

The condition of the wheel rim is also of importance to the endurance of the tire: bends, rust, and bumps destroy tire rims. Tires damaged in the rim cannot be repaired and constitute a serious hazard. The wheel rim must be checked regularly and thoroughly cleaned, the rust removed with a wire brush, and the rim afterwards lightly smeared with glycerin. If, for some reason, it is impossible to repair this damage, new wheel rims must be put on. If rust and bumps are removed only partially, after 2,000 - 3,000 kilometers, the tire should be rotated at least 45 degrees on the wheel rim, so that the place of contact with the rim will not be ruined.

It is important for the wheels to be properly aligned. Tires of different sizes should not be mounted on one axle. New tires should not be mounted on the same axle, with badly worn tires. Tires of the same dimensions but of different makes should not be used together, because their internal diameters often differ.

On cars with double wheels, a tire with a used tread should not be used together with a new tire, because this will result in overloading. For double wheels, the proper pressure in the outer tires is 1/4 - 1/2 atmosphere higher than that of the inner tires.

The use of improper tools in mounting tires can cause damage to the tire rim. Furthermore, the steel ring, the protective layers of rubber, and the cloth wound around the steel wire ring may be torn. Moisture penetrates the damaged place and can bring about the rusting of the steel wires and the destruction of the cord threads.

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The tire rims must be properly fitted into the grooves of the wheel rim. In an eccentric wheel rim, the rim of the tire must be fitted into the largest groove of the wheel rim and then, the opposite side of the tire carefully slid in over the edge of the rim. Otherwise, there is excessive strain, resulting in possible rupture of the protective bands. The tube must be inserted slightly inflated, with powder spread on the inside of the tire and on the tube. After the proper insertion of the tube, it is inflated to a pressure of about 1/2 atmosphere. For better handling, the majority of tires have indicator lines running above the bead, along the circumference of the tire. Only after the tire is properly mounted, is it inflated to the proper pressure. -- Engineer M. Muzalewski, Production Manager, Stomil.

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